Ontario Geological Survey
Aggregate Resources Inventory Paper 74

AGGREGATE RESOURCES INVENTORY OF NORTH DORCHESTER TOWNSHIP Middlesex County SOUTHERN ONTARIO

by
Staff of the Engineering and Terrain Geology Section
Ontario Geological Survey

1982

Ontario
Ministry of Natural Resources
Hon. Alan W. Pope
Minister
W. T. Foster
Deputy Minister

© OMNR-OGS 1982

Publications of the Ontario Ministry of Natural Resources
and price list
are obtainable through the
Ontario Ministry of Natural Resources, Map Unit, Public Service Centre
Queen's Park, Toronto, Ontario
and
The Ontario Government Bookstore
880 Bay Street, Toronto, Ontario

Orders for publications should be accompanied by cheque
or money order, payable to the Treasurer of Ontario

ISSN 0708-2061
ISBN 0-7743-6461-0

This report was prepared by: Staff of the Aggregate Assessment Office, Engineering and Terrain Geology Section of the Ontario Geological Survey, Ontario Ministry of Natural Resources, 77 Grenville Street, Toronto, M5S 1B3, Telephone (416) 965-1182.

Project Supervisor: Dale W. Scott
Text Prepared by: E. Garnet
Compilation and Drafting by: Staff of the Aggregate Assessment Office

The Mineral Resources Staff of Aylmer District and Southwestern Region of the Ministry of Natural Resources assisted in the collection of data, field checking and review of this report.

Parts of this publication may be quoted if credit is given to the Ontario Ministry of Natural Resources, Ontario Geological Survey. It is recommended that reference to this report be made in the following form:

Ontario Geological Survey
1982: Aggregate Resources Inventory of North Dorchester Township, Middlesex County; Ontario Geological Survey, Aggregate Resources Inventory Paper 74, 38 p., 7 tables, 3 maps, scale 1:50 000.

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

500-81-Carswell

CONTENTS

Page

Abstract v
Introduction 1
Part I - Inventory Methods 2
Field and Office Methods 2
Resource Tonnage Calculation Techniques 2
Sand and Gravel Resources 2
Bedrock Resources 3
Units and Definitions 3
Part II - Data Presentation and Interpretation 4
Map 1 Distribution of Sand and Gravel Deposits 4
Deposit Symbol 4
Texture Symbol 4
Map 2 Selected Sand and Gravel Resource Areas 5
Site Specific Criteria 5
Deposit Size 5
Aggregate Quality 5
Location and Setting 6
Regional Considerations 7
Map 3 Bedrock Resources 7
Selection Criteria 7
Selected Resource Areas 8
Part III - Assessment of Aggregate Resources in North Dorchester Township 9
Location and Population 9
Physiography and Surficial Geology 9
Extractive Activity 11
Selected Sand and Gravel Resource Areas 11
Selected Sand and Gravel Resource Area 1 11
Selected Sand and Gravel Resource Area 2 12
Selected Sand and Gravel Resource Area 3 13
Sand and Gravel Resources of Secondary Significance 13
Sand and Gravel Resources of Tertiary Significance 14
Bedrock Geology 14
Summary 14
References 27
Appendix A - Suggested Additional Reading 29
Appendix B - Glossary 30
Appendix C - Geology of Sand and Gravel Deposits 33
Appendix D - Geology of Bedrock Deposits 35

TABLES

1 - Total Sand and Gravel Resources, North Dorchester Township 16
2 - Sand and Gravel Pits, North Dorchester Township 17
3 - Selected Sand and Gravel Resource Areas, North Dorchester Township 20
4 - Total Identified Bedrock Resources, North Dorchester Township 21
5 - Quarries, North Dorchester Township 22
6 - Selected Bedrock Resource Areas, North Dorchester Township 23
7 - Summary of Test Hole Data, North Dorchester Township 24

FIGURES

1 - Key Map Showing Location of North Dorchester Township v
2 - Bedrock Geology of Southern Ontario 35

MAPS
(back pocket)

1 - Distribution of Sand and Gravel Deposits, North Dorchester Township, Scale 1:50 000.
2 - Selected Sand and Gravel Resource Areas, North Dorchester Township, Scale 1:50 000.
3 - Bedrock Resources, North Dorchester Township, Scale 1:50 000.

ABSTRACT

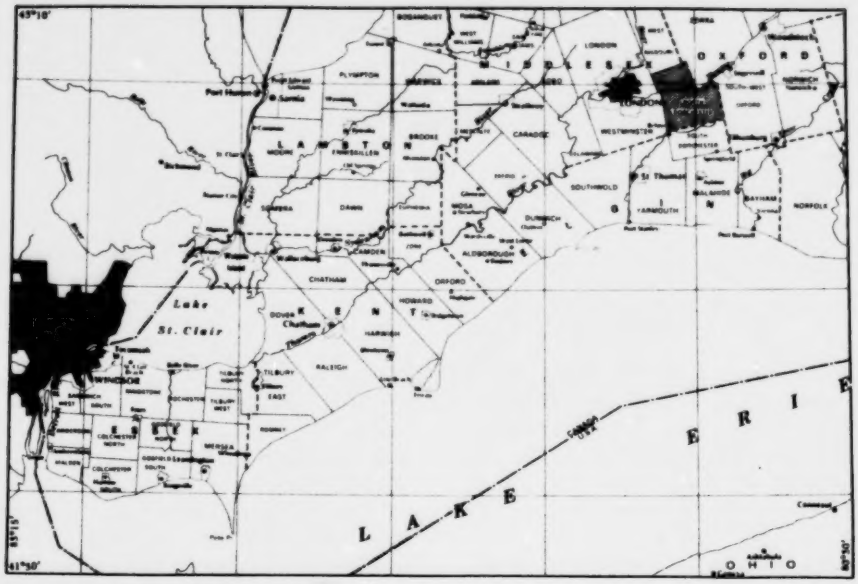


Figure I - Key Map Showing the Location of North Dorchester Township, Scale 1:1 800 000.

This report includes both an inventory and analysis of sand and gravel as well as bedrock resources in North Dorchester Township. The report is part of the Aggregate Resources Inventory Program for townships and municipalities designated under The Pits and Quarries Control Act, 1971.

Three sand and gravel deposits of primary significance are suggested for possible resource development and/or protection in North Dorchester. Selected Sand and Gravel Resource Areas 1, 2, and 3 are gravelly outwash deposits belonging to the Thames River meltwater channel. These areas occupy a total of 1990 acres (800 ha), exclusive of licenced properties. An estimated 1210 acres (490 ha) are currently available for extraction, containing approximately 76 million tons (69 million tonnes) of aggregate acceptable for a range of granular base course and hot-laid asphalt products. The parts of the Selected Areas which are available for extraction represent 8 percent of the township's total sand and gravel resources and 12 percent of the original tonnage.

Sandy outwash of the Thames River meltwater channel is also selected as a resource of secondary significance. This material, along with the remaining sand and gravel sources, should be considered as part of the township's aggregate supply.

The surficial deposits of North Dorchester are underlain by limestone of the Detroit River Group and the Dundee Formation. Although both units have economic value, the thickness of drift cover may prohibit extraction, except perhaps for small areas along the Thames River valley.

Selected Resource Areas are not intended to be permanent, single, land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

AGGREGATE RESOURCES INVENTORY OF NORTH DORCHESTER TOWNSHIP[1]

BY
STAFF OF THE ENGINEERING
AND TERRAIN GEOLOGY SECTION

INTRODUCTION

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1979, the total tonnage of mineral aggregates extracted was 144 million tons (131 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1980).

Although mineral aggregate deposits are plentiful in southern Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand, gravel and crushed bedrock. The most recent information available has been used to prepare the reports. As new information becomes available, revisions may be necessary.

[1] Manuscript accepted for publication by Chief, Engineering and Terrain Geology Section, October 30, 1981.
This paper is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

PART I - INVENTORY METHODS

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References). Field methods included the examination of natural and man-made exposures of granular material. Most observations were made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites included estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations were also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing and hand-augering techniques were used to assess subsurface materials. Airphotos at various scales were used to determine the continuity of deposits, especially in areas of limited subsurface information.

Deposits with potential for further extractive development or those where existing data are scarce, were studied in greater detail. Representative layers in these deposits were sampled in 25- to 100-pound (11 to 45 kg) units either from existing pit faces or from test pits dug by backhoe. The samples were analysed for grain size distribution and in some cases for petrographic assemblage. Analyses were performed by the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications. In areas of limited subsurface exposure, drilling using a powered hollow stem auger was undertaken. The stratigraphic sections in these test holes are described in drill logs included in the report as Table 7. In some cases samples taken during the course of the drilling were analysed to determine grain size distribution. The symbols for and locations of test hole sites are noted on Map 1.

In the office, the pit and field sample data were supplemented by information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size, and depth of extraction of pits licenced under The Pits and Quarries Control Act, 1971 were obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, were used in some areas to corroborate thickness estimates, or to indicate the presence of buried granular material. These records were used only in conjunction with other evidence. Soil reports published by the Ontario Ministry of Agriculture and Food were also consulted in order to supply additional information in areas with limited data. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a township base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data

such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) in extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 represent only those parts of the deposit lying outside licenced areas (Column 2). Two successive subtractions are made from the unlicenced area. Column 3 accounts for the number of acres unavailable due to the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas lying outside of licenced properties that have previously been extracted (e.g. wayside pits are included in this category). The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of favorable bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps and from the interpretation of water well records. The measured extent of such areas is then multiplied by the estimated workable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of a workable thickness of 60 feet (18 m) is used. Volume estimates are then multiplied by 3600 (the estimated weight in tons of a one-foot (0.3 m) thick section of dolostone, one acre (0.4 ha) in extent, assuming a bulk density of 165 pounds per cubic foot (2649 kg per cubic metre)).

Resources of sandstone are calculated using a bulk density estimate of 146 pounds per cubic foot (2344 kg per cubic metre) or approximately 3200 tons per acre (7173 tonnes per hectare). Shale resources are calculated on the basis of a bulk density estimate of 150 pounds per cubic foot (2408 kg per cubic metre).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel as well as bedrock-derived aggregates are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p. 7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

PART II - DATA PRESENTATION AND INTERPRETATION

Three maps, each portraying a different aspect of the aggregate resources in the municipality, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources", shows the distribution of bedrock formations, the thickness of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

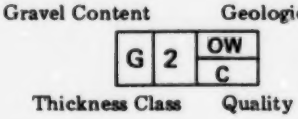
Map 1 is derived directly from the existing surficial geology maps of the area or from airphoto and field interpretation where surficial mapping is incomplete. It shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

The present level of extractive activity in the study area is indicated as follows. Those areas which are licenced for extraction under The Pits and Quarries Control Act, 1971 are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and percentage gravel. A number of unlicenced pits (abandoned pits or wayside pits operating on demand under authority of a permit) are also identified and numbered on Map 1 and described in Table 2.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for a given deposit. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate (greater than 4.75 mm) makes up less than 35 percent of the whole deposit. "G" indicates that the aggregate probably contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identify the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identify the main quality limitations that may be present in the deposit, as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The data from which these symbols are derived has been plotted on grain size distribution graphs. The relative amounts of gravel, sand, silt, and clay in the sampled material are shown graphically by the sub-

division of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol.

MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary; secondary; and tertiary. These areas are identified on Map 2 by different shading patterns. Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by a dark shading on Map 2.

Selected Sand and Gravel Resource Areas of primary significance are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by a light shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Although deposits of secondary significance are not considered to be the "best" resource areas in a municipality, they may contain large quantities of sand and gravel and should be considered an integral component of the aggregate supply of the municipality.

Areas of tertiary significance are indicated on the map by a dashed line but have no shading. They are neither rated nor considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the municipality is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

DEPOSIT SIZE

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6m) and containing more than 35 percent crushable gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

AGGREGATE QUALITY

The limitations of natural aggregates for various uses result from variations in the lithology of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content (G or S) indi-

cates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (or high silt and clay content) may severely limit the potential use of an aggregate. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphaltic aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock formations determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high-quality uses such as concrete or structures. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations. The Engineering Materials Office of the Ontario Ministry of Transportation and Communications has recently compiled a detailed assessment of aggregate suitability for selected areas in southern Ontario. This material has been consulted extensively in preparation of the inventory reports.

Analyses of unprocessed samples obtained from test holes and pits have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products — Granular Base Course A,B, and C; and Hot-Laid Asphaltic Sand Nos. 1, 2, 3, 4, 5, 6 and 8. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

LOCATION AND SETTING

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of those natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, power lines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits and bedrock resource areas with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report but

readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain at roughly the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology, bedrock topography, drift thickness maps, water well data from the Ontario Ministry of the Environment, oil and gas well data from the Petroleum Resources Section (Ontario Ministry of Natural Resources), and from geotechnical test hole data from various sources. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift, and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of the areas of thin drift are shown by three shades. The darkest shade indicates areas where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas constitute potential resource areas of primary significance because of their easy access. The medium shade indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these also represent potential resource areas. The lightest shade indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These latter areas constitute resources which have extractive value only in specific circumstances. Outside of these delineated areas the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive sand and gravel deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the municipality. Those areas which are licenced for extraction under The Pits and Quarries Control Act, 1971 are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location, and licenced acreage of the quarry and an estimate of face height. Unlicenced quarries (abandoned quarries or wayside quarries operating on demand under authority of a permit) are also identified and numbered on Map 3 and described in Table 5. One additional symbol appears on the map: an open dot indicates the location of a selected well which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and

Communications. The main characteristics and uses of the bedrock formations found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations of sufficient thickness to support quarry operations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource is usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of Bedrock Resource Areas has been restricted to a single level of significance. Three factors support this approach. First, quality and quantity variations are gradual. Second, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and third, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The Selected Areas are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such a resource area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

PART III - ASSESSMENT OF AGGREGATE RESOURCES IN NORTH DORCHESTER TOWNSHIP

LOCATION AND POPULATION

North Dorchester Township occupies 55,026 acres (22 269 ha) in the extreme southeast corner of Middlesex County, southwestern Ontario. The township is bounded by Zorra to the northeast, West Nissouri to the north, London and the City of London to the northwest, Westminster to the west, South Dorchester to the south, and South-West Oxford to the east. North Dorchester Township and portions of the surrounding municipalities are shown on the Lucan (40 P/3), Woodstock (40 P/2), Tillsonburg (40 I/15) and St. Thomas (40 I/14) map sheets of the National Topographic System at a scale of 1:50 000.

The dominant land use is agriculture, with residential development concentrated mainly in small hamlets such as Crampton, Mossley, Putnam, Crumlin, Nilestown, and the larger village of Dorchester. There are also large numbers of rural-nonfarm dwellings scattered across the township. The total population of North Dorchester was 6820 in 1980. This figure is a 4 percent increase over the 1972 population of 6537 (Ontario Ministry of Intergovernmental Affairs 1981; Ontario Ministry of Treasury, Economics, and Intergovernmental Affairs 1974).

Future development within the township will be markedly influenced by growth of the City of London. The Planning Directorate for the city has projected a 2 percent per annum growth rate by 1982, which would increase the city's population to 400 000 by 2001 (Brian Turnbull and Associates Ltd. 1978). As a result, the surrounding townships, including North Dorchester, may experience an increasing commuter demand for rural-nonfarm and urban residential development, as well as for the necessary service and commercial facilities. The planning response in North Dorchester, for example, will be to concentrate otherwise haphazard residential growth in a number of designated hamlets in order to relieve the pressure on valuable agricultural land.

Unfortunately, mineral aggregates are in short supply from the London area westward to Sarnia. London's continued growth and its possible spin-off in North Dorchester will require increased production for industrial and residential construction and for road building and maintenance. Therefore, a critical assessment of aggregate resources in the township is necessary in order that present sand and gravel reserves can be adequately developed and/or protected for future use.

Sand and gravel reserves in North Dorchester are located in close proximity, not only to London, but to other regional centres, such as Woodstock, and St. Thomas. Accessibility is provided by King's Highway 401 which crosses the centre of the township in an east-west direction and by Highway 2 which forms the northern boundary. Other roads include King's Highways 73 and 74, and county and suburban roads. In addition, there are two rail lines: the Canadian National runs through Dorchester village and the Canadian Pacific line crosses the southern part of the township.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

North Dorchester Township has gently rolling to hummocky topography made up of a series of morainic ridges and valleys which parallel the Lake Erie shore. Local relief is approximately 100 feet (30 m) with only a few slopes exceeding 10 percent (Chapman and Putnam 1966, p. 233). The ridges are well drained and form the divides for the area's drainage system which includes the Thames River. The intervening valleys are shallow and elongate. These former meltwater channels are now often poorly drained and some contain swampy areas and bogs. The physiography of the area and land use activities are further discussed by Chapman and Putnam (1966). The reader is specifically referred to descriptions of two physiographic regions: the Caradoc Sand Plains and London Annex (pp. 236-238) and the Mount Elgin Ridges (pp. 233-236).

The surficial geology of the township is complex and certain aspects of its geological history are currently being revised. In brief, the

current landscape and the distribution of surficial materials are a result of the advance and melting back of massive, continental ice sheets. The most significant glacial events in North Dorchester occurred mainly during the Port Bruce Stadial of the Late Wisconsinan Substage, approximately 15 000 to 14 000 years ago.

Major advances from an ice lobe located in the Lake Erie basin overrode earlier tills and lacustrine sediments and deposited several layers of material known as the Port Stanley Till. This material covers roughly the southern two-thirds of the township and in places the surface is fluted and drumlinized. The Port Stanley Till is a brown to dark brown, silt to clay silt till with a low clast content (Barnett 1980, p. 31). The fine-grained nature of the till makes it unacceptable for any granular use.

The Port Stanley Till is the constituent material of the Ingersoll and Westminster Moraines which trend across the township in an east-west direction, south of the Thames River. The Ingersoll Moraine represents the limit of the Port Stanley ice and is reported to contain 39 to 108 feet (12 to 33 m) of the till underlain by sand and gravel, in turn overlying older till (Barnett 1980, p. 41). Although the till is coarsest along the moraine ridges, the high chert and silt content make the material unsuitable for aggregate. However, both the Ingersoll and Westminster Moraines contain small, isolated pockets of ice-contact stratified drift which may have some limited use. These deposits are predominantly sand with patches of sandy silt till (Barnett 1980, p. 53).

While the Port Stanley Till was being deposited south of the Thames River, glacial ice from the Lake Huron basin was depositing the Tavistock Till to the north. This till, which also overlies part of the Ingersoll Moraine, is a gritty clayey to sandy silt till becoming sandier to the southeast corner of its extent in North Dorchester (Sado 1980a, p. 35). An older, subdued feature — the Dorchester Moraine — was overridden by the ice and covered by the Tavistock Till. The till overlying the moraine is interlain with layers of sand and gravel. The upper till layers are sandier due to the incorporation of the underlying sandy material. Generally, the Tavistock Till is unsuitable for granular use, because of its high fines content.

The margins of the Huron and Erie ice lobes met at the Ingersoll Moraine. Gradual melting back from the interlobate zone resulted in vast amounts of meltwater flowing westward in a channel now occupied by the Thames River. While the Erie ice lobe stood at the Westminster Moraine, meltwaters breached the Ingersoll Moraine at Putnam. Reynolds Creek is the misfit stream which occupies the old meltwater channel that once contributed glacial runoff to the larger Thames channel. The outwash material deposited by the combined runoff from the two ice lobes may cover a larger area than is indicated by present Quaternary mapping. A recent study by Sado (1980b) suggests that granular deposits from 50 to 70 feet (15 to 21 m) thick may underlie much of the surface in North Dorchester. The quality of the aggregate is undetermined, although Sado (1980b, p. 8) believes a figure of 10 to 25 percent fine gravel would be reasonable.

Fluctuations of the Erie lobe along the Westminster Moraine also resulted in the formation of a large glacial lake. Lake Maumee II existed between the ice front and the Ingersoll Moraine where drainage was restricted by the narrow Reynolds Creek channel at Putnam. A thin veneer of fine-grained lacustrine sediments can generally be observed below the 925-foot (282 m) contour in scattered locations south of the Ingersoll Moraine (Barnett 1980, p. 57). North of the Thames River, glaciolacustrine material is most noticeable between members of the Tavistock Till and to a lesser extent on the surface, where local depressions are partly filled with material eroded from the adjacent till knolls (Sado 1980a, pp. 80-82).

An additional product of glacial activity in North Dorchester is represented by swampy areas and bogs, often caused by the settling of isolated, stagnant ice blocks in abandoned meltwater channels. The resultant depressions, or kettles, are poorly drained and several have no outlets. The Dorchester Swamp, for example, is situated in a large kettle. Smaller kettles include the shallow depressions containing Mud Lakes and Foster Ponds.

Glacial activity after the Port Bruce Stadial was of minor importance in the township. Sado and Vagners (1975) mention that modern floodplain alluvium is predominantly silty, but may contain some poorly stratified sand and gravel. Some terrace deposits, intermediate in origin to present day and older glacial streams,

are similar to outwash (Cowan 1975, p. 48). However, modern alluvium is generally less than 10 feet (3 m) thick and is too fine grained to be of economic use as aggregate.

EXTRACTIVE ACTIVITY

A total of twenty-two sand and gravel pits were identified in North Dorchester Township, including several that are overgrown and currently inactive. At present, nineteen of the pits are licenced to operate under The Pits and Quarries Control Act, 1971. The licenced properties have a total area of 778.9 acres (315.2 ha). All of the licenced pits are located in sand or gravel outwash which originated from the Huron and Erie ice lobes. Although several of the pits contain water and appear overgrown, aggregate is extracted from below the water table, indicating additional material is available at depth.

Total production figures for licenced sources have been compiled annually by the Aylmer District Office of the Ontario Ministry of Natural Resources since designation of the township in 1971. The average annual production between 1974 and 1978 was 518,462 tons (470 349 tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 1 indicates the deposits which contain granular materials. The total extent of these deposits is approximately 15,800 acres (6400 ha), representing an original tonnage of 660 million tons (600 million tonnes). Many of these potential resources have limited value for reasons of deposit size, thickness or quality of the material. Consequently, only the most significant sources are suggested for development and/or protection at the primary level.

The three sources of primary value are outwash deposits related in origin to the Thames River meltwater channel of the Huron-Erie interlobate zone. These deposits contain good-quality sand and gravel to depths of about 25 to 30 feet (8 to 9 m). Sado's (1980b) recent analysis of water well and test hole data suggests the aggregate continues to a greater depth. However, there is still uncertainty regarding the quality of this buried material.

The three primary areas total 1990 acres (800 ha), exclusive of licenced properties. Approximately 1210 acres (490 ha) are currently available for extraction. Assuming a conservative average thickness for each area, total aggregate resources are estimated to be 76 million tons (69 million tonnes), or 12 percent of the original tonnage (Table 1).

Sources of secondary value are also outwash deposits belonging to the Huron-Erie interlobate zone. The material is predominantly sandy and highly variable. The secondary areas would require further investigation to confirm the depth and quality of any additional buried aggregate.

Other deposits are relatively less important and are classed at the tertiary level. At present, these are not the "best" sources, although they should be considered as part of the township's aggregate supply. As indicated above, further investigation may confirm more granular material at depth.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Sand and Gravel Resource Area 1 is a gravel outwash deposit of approximately 2100 acres (850 ha) associated with the Huron-Erie interlobate zone. The Dorchester Moraine makes up part of this area and the landscape is gently rolling to hummocky with some swampy depressions. The moraine is a complex feature composed of up to 12 feet (4 m) of sandy Tavistock Till overburden resting on older sand and gravel interlain with layers of till — the latter material was presumably deposited by blocks of ice in a stagnant environment (Sado 1980a, p. 71). Other parts of the area are till free and have little or no overburden.

Field examination of pits in the resource area revealed a high degree of variability with crushable aggregate tending to occur in pockets. Coarse aggregate in the range of 50 to 80 percent gravel was observed in the southern half of the deposit. A 10- to 15-foot (3 to 5 m) face in pit 9, for example, exposed medium to coarse gravel mixed with medium to coarse sand. The poorly sorted, rounded to subangular pebbles occurred in layers 1 to 2 feet (0.3 to 0.6 m) in thickness and were interlayered with clayey medium sand. Similarly, a test hole excavated by the Ontario Ministry of Transportation and Communications (M.T.C.) in pit 19 showed poorly sorted, medium to coarse gravels mixed

with medium to coarse sand.

In the northern half of the deposit, gravel content observed was from 30 to 65 percent. Exposed 8- to 10-foot (2 to 3 m) faces in pit 3 indicated an overall 40 to 50 percent gravel content. The gravel layers had poorly sorted, medium to coarse, rounded to subangular pebbles mixed with coarse sand. Intervening layers contained medium sand. Pits 4 and 6 are coarser — in the range of 50 to 65 percent gravel. Hewitt and Cowan (1969, p. 34) described a 14-foot (4 m) face in pit 6 as having ". . . 8 feet of southwest dipping, foreset gravel overlying 6 feet of poorly sorted, flat lying gravels containing up to 10 percent silt and clay." The authors continued to describe a stone content of 80 to 85 percent, with 40 to 50 percent of the pebbles exceeding 1 inch (2.5 cm) in diameter. Pit 2, however, is located in much finer material. Here, the gravel content in a 10- to 15-foot (3 to 5 m) face did not exceed 30 to 40 percent. Gravel layers were about 1.5 feet (0.5 m) thick and contained poorly sorted, fine to medium pebbles mixed with medium sand.

Test hole data (Sado 1980 b) obtained just to the south of the Resource Area (Map 1 and Table 7) may be similar to parts of the deposit. Test holes ND-TH-1, 2, and 3 showed 6 to 14 feet (2 to 4 m) of gritty silty sand till overlying sand with varying quantities of gravel to about 60 feet (18 m). The fine to coarse sand is clean and well sorted with gravelly layers (Sado 1980b, p. 3). The pits in the deposit have been extracted to a depth ranging from 5 to 20 feet (2 to 6 m), with additional material often draglined from below the water table. A number of the pits already contain water. Pit 2, for example, may have good material for another 15 feet (5 m) below water. Based on the recent test hole data, further extraction in these pits may be possible, provided the quality and depth of the material can be confirmed and lowering of the water table can be avoided. Extraction may not be possible beyond 30 feet (9 m) below the surface (Comment by P. Palonen; The Signpost 1980).

Deike (1981) comments that although the pits are often sandy, a number contain sufficient cobbles and boulders to enable economic crushing. Granular Base Course (G.B.C.) A and Hot-Laid (H.L.) No. 4 surface paving aggregate can, therefore, be produced by selective screening and sand control. Selective screening also minimizes the undesirable chert and shale components. The sand fractions grade coarse and dirty and blending is necessary for hot-laid asphalt products Minor cementation may also be a problem where the aggregate is overlain by till (Barnett 1980, p. 89).

Resource Area 1 is approximately 1700 acres (690 ha), exclusive of the licenced properties. Deletions for cultural setbacks and previous extraction further reduce the available area to 1090 acres (440 ha). Additional constraints are provided by the Thamesford Woodlot — an environmentally sensitive area of cedar swamps and upland woodlots. Assuming good-quality material exists to an average depth of 25 feet (8 m), the total available aggregate is estimated to be 68 million tons (62 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Sand and Gravel Resource Area 2 is a hummocky area of till-capped, gravel outwash situated on the north slope of the Ingersoll Moraine. The deposit is small and largely under licence to two pit operators.

Pits 15 and 16 had faces about 20 to 25 feet (6 to 8 m) high and exposed material with a gravel content of 60 to 70 percent. The gravel layers were distinct and interbedded with layers of fine to medium sand. The gravel, although coarse, was poorly sorted and mixed with medium to coarse sand. In addition, both pits had a 2-foot (0.6 m) seam of predominantly oversized material crossing the exposed faces.

Test holes ND-TH-4 and 5 showed that sand and gravel continue to a depth of 75 feet (23 m) below the surface (Sado 1980b). The material is reported by Sado to be clean and well sorted.

Deike (1981) indicates that the deposit contains good-quality crushable material acceptable for hot-laid asphalt and concrete uses. Oversize material is present in objectionable quantities and must be removed or crushed for G.B.C. B. The sand is coarse and has a high silt content. Blending is, therefore, necessary in order to produce hot-laid products. Minor cementation may also be a problem (Barnett 1980, p. 89).

Resource Area 2 occupies approximately 40 acres (16 ha), exclusive of the licenced properties. Deletions for cultural setbacks leave 20 acres (8 ha) remaining for extraction. As the quality of the aggregate observed in the test hole data has not been determined accurately, an average deposit thickness of 30 feet (9 m) was used for the resource tonnage calculation. Consequently, the estimated aggregate resources are 2 million tons (2 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREA 3

Sand and Gravel Resource Area 3 is part of a gravel outwash deposit also selected at the primary level in South-West Oxford. The material is associated with the Thames River meltwater channel of the Huron-Erie interlobate zone. Barnett (1980, p. 55) stated that the channel outwash is usually about 20 feet (6 m) thick with a gravel content of 20 to 40 percent.

The above figures cannot be confirmed because of the lack of data in the North Dorchester portion of the deposit. However, two licenced excavations in South-West Oxford revealed face heights of 10 to 20 feet (3 to 6 m) and 40 feet (12 m). The exposed material was variable and ranged from 20 to 65 percent gravel.

Supplementary data obtained from Hewitt and Cowan (1969) for other pits to the east of Resource Area 3 indicated poorly sorted coarse gravel with a few sand lenses. Gravel content ranged from 80 to 90 percent. As the Thames River outwash grades finer to the west, gravel contents are probably lower in North Dorchester. Cowan (1975, p. 52) explains that the pebble fraction is often too fine for crushing. Deike (1981) describes the deposit as mainly a sand source acceptable for G.B.C. B, C, and select subgrade material. Minor cementation may be a problem where the aggregate is overlain by Port Stanley Till (Barnett 1980, p. 89) and chert is common throughout (Cowan 1975, p. 52).

Resource Area 3 totals approximately 250 acres (101 ha). Although there has been no previous extraction, cultural setbacks reduce the available area to 100 acres (40 ha). Assuming an average deposit thickness of 25 feet (8 m), estimated sand and gravel resources are 6 million tons (5 million tonnes).

SAND AND GRAVEL RESOURCES OF SECONDARY SIGNIFICANCE

Two large areas of sandy outwash are suggested for resource development and/or protection at the secondary level. These areas are also associated with the Thames River meltwater channel.

The sandy outwash deposits to the north of the Thames River contain materials that are highly variable. Ontario Hydro subsurface testing data indicate layers of silty fine sand with some clay, and traces of clay, coarse sand and fine gravel to a depth of 32 feet (10 m). Pit 1 exhibited similar material in an exposed 5- to 15-foot (2 to 5 m) face. The sand was very fine with a high silt content. Crossbedding and deformation structures were evident which may indicate that the deposit possibly formed in a stagnant ice environment. The sand has been used for blending and is acceptable for select subgrade material.

The outwash deposit to the south of the Thames River is also highly variable with a high silt content. Pits 11, 12, 13, and several abandoned sites had shallow, sloughed faces and were completely water filled. The stockpiled material observed in the pits which was draglined from below the water is used for G.B.C. A and B. Although some sites may have sufficient cobbles and boulders for selective crushing, the deposit is predominantly sand (Deike 1981). Extraction in the deposit may be restricted by the proximity of the Dorchester Swamp — an environmentally sensitive area with swamp vegetation and with a water table at or near the ground surface.

In addition, a small area of gravel outwash to the south of Putnam is also suggested for consideration at the secondary level. This deposit was formed along the Reynolds Creek meltwater channel. A water well in the deposit showed 10 feet (3 m) of sand overlying 60 feet (18 m) of gravel. Excavated material from a small pond contained coarse, rounded pebbles. Although no further information is available on this site, a description by Barnett (1980, pp. 90-91) of Reynolds Creek outwash to the east of North Dorchester indicates the material could have a high gravel content with chert present.

SAND AND GRAVEL RESOURCES OF TERTIARY SIGNIFICANCE

Deposits suggested for development and/or protection at the tertiary level contain materials with significant quality limitations. Although these are not the "best" sources, they should be considered as part of the township's total aggregate supply.

In North Dorchester, tertiary deposits are mainly sand outwash of the Thames River and Reynolds Creek meltwater channels. Pits 21 and 22 both exposed fine to medium sand in horizontal layers. Gravel outwash belonging to the same channels have a higher stone content. Pit 14, for example, had 10- to 20-foot (3 to 6 m) faces with a gravel content of 50 to 60 percent. This pit is a nearly depleted source, but the aggregate was once acceptable for G.B.C. B and C, and select subgrade material. Chert is a deleterious component of the deposit and the sand fraction tends to grade coarse and dirty.

Ice-contact stratified drift deposits are often found along the Ingersoll Moraine. These deposits are usually small and till capped. An abandoned pit in sandy ice-contact material to the east of Putnam had a face 10 to 15 feet (3 to 5 m) high with a gravel content of 30 to 40 percent. Some oversized stone was present. The area is hummocky and has swampy depressions which may hinder extractive activities.

Additional aggregate may be available in areas which have not yet been investigated. Sado's (1980b) recent analysis suggests sand and gravel may exist in considerable quantities in the Huron-Erie interlobate zone. Many areas, however, appear to be capped by a large overburden of till which may make extraction uneconomical. Test hole ND-TH-6, for example, indicated about 70 feet (21 m) of clean, well sorted sand with some gravel underlying almost 40 feet (12 m) of Port Stanley and Tavistock tills (Sado 1980b). Ontario Hydro transmission line data also described till-like material to depths of approximately 30 feet (9 m).

BEDROCK GEOLOGY

The Detroit River Group underlies the surficial deposits in east-central North Dorchester. The group consists of two, lithologically similar formations — the Amherstburg and Lucas Formations, but only the Lucas Formation is found in the township. The thickness of the Detroit River Group increases from 0 feet (0 m) southeast of Norwich to 110 feet (34 m) at Beachville and 197 feet (60 m) at St. Marys (Hewitt 1972, p. 11). In North Dorchester, the average thickness is assumed to be 60 feet (18 m). The rock is mainly high-purity calcium limestone. This limestone is quarried outside the township at Beachville for the production of lime, crushed stone, and flagstone, and for the manufacture of portland cement at St. Marys and Zorra Station. An area covered by less than 50 feet (15 m) of drift is found in North Dorchester along the Thames River valley. Quarrying for limestone is possible in this area, but extraction may be restricted by environmental concerns associated with the river's floodplain. South of the Thames River, drift thickness rapidly increases. In addition, the upper portions of the Lucas Formation limestone tend to be sandy in this area, further restricting the economic desirability of extracting the material.

The Dundee Formation overlies the Detroit River Group in the remainder of the township. The formation ranges in thickness from 60 to 160 feet (18 to 49 m) and consists of medium-grained limestone with some chert (Hewitt 1972, p. 12). The limestone is quarried at St. Marys for the manufacture of portland cement and elsewhere in southwestern Ontario for crushed stone. Quarrying may be possible in a thinly drift-covered area along the Thames River valley. However, in the rest of the township, drift cover ranges from 50 to more than 300 feet (15 to 91 m).

SUMMARY

The sand and gravel deposits of North Dorchester Township are mainly the product of glacial activity which occurred during the Late Wisconsinan. The primary and secondary resource areas contain outwash material belonging to the Thames River meltwater channel of the Huron-Erie interlobate zone. Although these resources tend to be variable, much good-quality aggregate remains in the deposits. In addition, recent investigation has demonstrated that sand and gravel may continue to a considerable depth below the present level of extraction. The buried aggregate requires further testing to determine its quality and the optimal depth of excavation.

Two bedrock units underlie the surficial material. Limestone of the Detroit River Group has been quarried in neighbouring municipalities for the production of lime, portland cement, flagstone and crushed stone. The limestone of the Dundee Formation has also been quarried for crushed stone and the manufacture of portland cement. With the exception of small areas along the Thames River valley, drift cover is generally too great to permit economic extraction in North Dorchester.

Enquiries regarding the Aggregate Resources Inventory of North Dorchester Township should be directed to the Ontario Ministry of Natural Resources at the Aylmer District Office, 353 Talbot Street West, Aylmer, Ontario, N5H 2S8 (Tel. (519) 773-9241) or at the Southwestern Region Geological Office, 458 Central Avenue, London, Ontario, N6B 2E5 (Tel. (519) 433-8431).

TABLE 1 | TOTAL SAND AND GRAVEL RESOURCES, NORTH DORCHESTER TOWNSHIP

1 CLASS NO.	2 DEPOSIT TYPE (see Appendix C)	3 AREAL EXTENT Acres (Hectares)	4 ORIGINAL TONNAGE Millions of Tons (Tonnes)
1	G-OW	2700 (1090)	168 (152)
2	G-IC	35 (14)	1 (1)
	S-IC	130 (53)	5 (4)
	G-OW	630 (255)	22 (20)
	S-OW	8900 (3600)	430 (390)
3	G-LB	50 (20)	1 (1)
	G-OW	90 (36)	2 (2)
	S-OW	208 (84)	4 (4)
4	S-IC	30 (12)	<1 (<1)
	S-LP	1880 (760)	19 (17)
	S-OW	1150 (465)	12 (11)
		15,800 (6400)	660 (600)

N.B. Minor variations in above table are due to rounding of data.

TABLE 2 | SAND AND GRAVEL PITS, NORTH DORCHESTER TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
LICENCED PITS							
1		J.F. Marshall and Sons, Ltd.	Pt. 10	1 (N.T.R.)	99.0 (40.1)	5-15 (2-5)	sand partly overgrown
2		Stebbin Paving and Const. Ltd.	N½ 14, 15	1 (N.T.R.)	122.8 (49.7)	10-15 (3-5)	30-50 partly overgrown
3		Stebbin Paving and Const. Ltd.	E½ 16	1 (N.T.R.)	23.3 (9.4)	8-10 (2-3)	40-50 partly overgrown
4		Stebbin Paving and Const. Ltd.	Pt. NE½ 16	1 (N.T.R.)	19.0 (7.7)	10-15 (3-5)	60-65 sloughed and partly overgrown
5		Stebbin Paving and Const. Ltd.	N½ 17	1 (N.T.R.)	65.0 (26.3)	5-10 (2-3)	60-65 sloughed and partly overgrown
6		J. Alderson Contracting Ltd.	N½ 18	1 (N.T.R.)	70.0 (28.3)	10-15 (3-5)	50-60 sloughed and partly overgrown; excavated below water
7		J.F. Marshall and Sons, Ltd.	Pt. 15, 16	1 (N.T.R.)	98.0 (39.7)	10-12 (3-4)	60-70 test hole only
8		Township of North Dorchester	Pt. S½ 17 Pt. 17	3 (N.T.R.)	5.0 (2.0)	10-15 (3-5)	50-60 sloughed and overgrown

TABLE 2 | SAND AND GRAVEL PITS, NORTH DORCHESTER TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
9		V.W. Ruckle	17, 18	4 (N.T.R.)	70.0 (28.3)	10-15 (3-5)	60-70 sloughed and partly overgrown; excavated below water
10		Township of North Dorchester	Pt. 17	4 (N.T.R.)	14.0 (5.7)	15-20 (5-6)	60-70 backfilled
11		Anthony P. Aartes	Pt. 14	B (S.T.R.)	9.0 (3.6)	<5 (<2)	sandy stockpiles; water filled and overgrown
12		County of Middlesex	Pt. N½ 13	B (S.T.R.)	10.5 (4.2)	<5 (<2)	sloughed; overgrown and water filled
13		Stewart Nethercott	13	B (S.T.R.)	8.3 (3.4)	<5 (<2)	sloughed; overgrown and water filled
14		Walmsley Brothers	Pt. 4, 5	B (S.T.R.)	74.5 (30.2)	10-20 (3-6)	50-60 sloughed and partly overgrown
15		Township of North Dorchester	Pt. S½ 9, 10	1 (S.T.R.)	19.4 (7.8)	20-25 (6-8)	60-70 sloughed and partly overgrown
16		Talbot Sand and Gravel Ltd.	S½ 9	1 (S.T.R.)	23.6 (9.6)	20-25 (6-8)	60-70 sloughed and partly overgrown
17		Brent-Reg Construction	Pt. N½ 4, 5	2 (S.T.R.)	9.4 (3.8)	5-10 (2-3)	30-40 sloughed and partly overgrown

TABLE 2 | SAND AND GRAVEL PITS, NORTH DORCHESTER TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREAS Acres (Hectares)	7 FACE HEIGHT Feet (Metres)	8 % GRAVEL
18		Paul Herman Hanson	Pt. 17	3 (N.T.R.)	8.2 (3.3)		no excavation
19		N.J. Spivak Ltd.	Pt. 18	3 (N.T.R.)	29.9 (12.1)	5-10 (2-3)	70-80 testhole
					778.9 (315.2)		
UNLICENCED PITS*							
20	L7-173	Wilson	17	3 (N.T.R.)		5-10 (2-3)	70-80 testhole
21	ST9-115	G. Tiner	19	A		10-20 (3-6)	sand sloped
22	T3-74	Unknown	2	1 (S.T.R.)		5-8 (2)	sand

N.B. Minor variations in the above table are due to rounding of data.

* Abandoned pits or wayside pits operating on demand under authority of a permit.

TABLE 3 | SELECTED SAND AND GRAVEL RESOURCE AREAS, NORTH DORCHESTER TOWNSHIP

1 **DEPOSIT NO.**	2 **UNLICENCED AREA** Acres (Hectares)	3 **CULTURAL SETBACKS** Acres (Hectares)	4 **EXTRACTED AREA** Acres (Hectares)	5 **AVAILABLE AREA** Acres (Hectares)	6 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	7 **AVAILABLE AGGREGATE** Millions of Tons (Tonnes)
1	1700 (690)	590 (239)	20 (8)	1090 (440)	25 (8)	68 (62)
2	40 (16)	20 (8)	0 (0)	20 (8)	30 (9)	2 (2)
3	250 (101)	150 (61)	0 (0)	100 (40)	25 (8)	6 (5)
	1990 (800)	760 (310)	20 (8)	1210 (490)		76 (69)

N.B. Minor variations in the above table are due to rounding of data.

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, NORTH DORCHESTER TOWNSHIP

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
25-50 (8-15)	Dundee Formation	60 (18)	370 (150)	80 (73)
25-50 (8-15)	Detroit River Group	60 (18)	700 (285)	150 (136)
			1070 (435)	230 (209)

N.B. Minor variations in above table are due to rounding of data.

TABLE 5 | QUARRIES, NORTH DORCHESTER TOWNSHIP

1 NO.	2 MTC NO.	3 OWNER/OPERATOR	4 LOT	5 CON.	6 LICENCED AREA Acres (Hectares)	7 FACE HEIGHT Feet (Metres)

– NONE –

TABLE 6 | SELECTED BEDROCK RESOURCE AREAS, NORTH DORCHESTER TOWNSHIP

1 **DEPOSIT NO.**	2 **DEPTH OF OVERBURDEN** Feet (Metres)	3 **UNLICENCED AREA** Acres (Hectares)	4 **CULTURAL SETBACKS** Acres (Hectares)	5 **EXTRACTED AREA** Acres (Hectares)	6 **AVAILABLE AREA** Acres (Hectares)	7 **ESTIMATED WORKABLE THICKNESS** Feet (Metres)	8 **AVAILABLE RESOURCES** Millions of Tons (Tonnes)

– NONE –

TABLE 7 | SUMMARY OF TEST HOLE DATA, NORTH DORCHESTER TOWNSHIP (FROM SADO 1980b)

Test Hole Number: ND-TH-1

Location: Lot 18, Con. 4 (N.T.R.)

Elevation: 895 feet (273 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-11.5 (0-3.5)	gritty silty sand till (Tavistock Till)
11.5-57.0 (3.5-17.4)	clean medium to coarse sand, well graded, contains gravelly layers
57.0-70.0 (17.4-21.3)	compact, stony silty sand till (Catfish Creek Till)[1]

Test Hole Number: ND-TH-2

Location: Lot 15, Con. 5 (N.T.R.)

Elevation: 890 feet (271 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-6.0 (0-1.8)	gritty silty sand till (Tavistock Till)
6.0-54.0 (1.8-16.5)	silty fine sand grading to clean coarse sand containing gravelly layers
54.0-59.0 (16.5-18.0)	silty sand till
59.0-66.0 (18.0-20.1)	compact, stony silty sand till (Catfish Creek Till)

1. Catfish Creek Till is the product of earlier glacial events which occurred during the Nissouri Stadial.

TABLE 7 | SUMMARY OF TEST HOLE DATA, NORTH DORCHESTER TOWNSHIP (FROM SADO 1980b)

Test Hole Number: ND-TH-3

Location: Lot 16, Con. 4 (N.T.R.)

Elevation: 885 feet (270 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-14.0 (0-4.3)	gritty silty sand till (Tavistock Till)
14.0-28.0 (4.3-8.5)	clean, well sorted sand grading to gravel and gravelly sand with depth
28.0-58.0 (8.5-17.7)	gravelly silty sand
58.0-66.0 (17.7-20.1)	compact, stony silty sand till (Catfish Creek Till)

Test Hole Number: ND-TH-4

Location: Lot 9, Con. 1 (S.T.R.)

Elevation: 900 feet (274 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-3.0 (0-0.9)	gritty sandy silt till (Tavistock Till)
3.0-33.0 (0.9-10.1)	cobbly gravels and coarse sand, well sorted, clean
33.0-75.0 (10.1-22.9)	clean, well sorted sand and some bouldery to cobbly gravel

hole terminated due to penetration difficulty in coarse gravel-boulders

TABLE 7 | SUMMARY OF TEST HOLE DATA, NORTH DORCHESTER TOWNSHIP (FROM SADO 1980b)

Test Hole Number: ND-TH-5

Location: Lot 9, Con. 1 (S.T.R.)

Elevation: 925 feet (282 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-55.0 (0-16.8)	clean, well sorted sand and gravel materials

Test Hole Number: ND-TH-6

Location: Lot 6, Con. 1 (S.T.R.)

Elevation: 945 feet (288 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-25.0 (0-7.6)	gritty clay silt till (Port Stanley Till)
25.0-37.0 (7.6-11.3)	gritty clayey silt till (Tavistock Till)
37.0-105.0 (11.3-32.0)	clean, well sorted sand with some gravel

Test Hole Number: WT-TH-1

Location: Lot 1, Con. 1 (Westminster Township)

Elevation: 870 feet (265 m) a.s.l.

DEPTH feet (metres)	DESCRIPTION
0-13.0 (0-4.0)	gritty sandy silt till (Tavistock Till)
13.0-28.0 (4.0-8.5)	silty fine sand grading to clean gravelly coarse sand
28.0-75.0 (8.5-22.9)	compact, stony silty sand till (Catfish Creek Till)

REFERENCES

Association of Professional Engineers of Ontario
1976: Performance Standards for Professional Engineers Advising on and Reporting on Oil, Gas and Mineral Properties; Association of Professional Engineers of Ontario, 11 p.

Barnett, P.J.
1980: Quaternary Geology of the Tillsonburg Area, Southern Ontario; Ontario Geological Survey, Open File Report 5308, 130 p.

Barnett, P.J.; Girard, C.K.; Spratt, G.; and Kmiecik, C.M.
1976: Quaternary Geology of the Tillsonburg Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P. 1214, Geological Series, scale 1:50 000.

Barnett, P.J. and Starkoski, A.L.
1978a: Bedrock Topography of the Tillsonburg Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P. 1567, Bedrock Topography Series, scale 1:50 000.
1978b: Drift Thickness of the Tillsonburg Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P. 1568, Drift Thickness Series, scale 1:50 000.

Brian Turnbull and Associates Ltd.
1978: Township of North Dorchester, Official Plan, Rural Area, Background Reports.

Chapman, L.J. and Putnam, D.F.
1966: The Physiography of Southern Ontario; Second Edition, Ontario Research Foundation, The University of Toronto Press, 386 p.

Cowan, W.R.
1975: Quaternary Geology of the Woodstock Area, Southern Ontario; Ontario Division of Mines, Geological Report 119, 91 p. Accompanied by Maps 2281 and 2282, scale 1:63 360.

Deike, W.
1981: Aggregate Suitability Evaluation, Township of North Dorchester; Soils and Aggregate Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, 5 p, unpublished report.

Dreimanis, A.
1968: St. Thomas Sheet, Southern Ontario; Ontario Department of Mines, Preliminary Map P. 482, Bedrock Topography Series, scale 1:50 000.
1970: Pleistocene Geology of the St. Thomas Area (East Half); Ontario Department of Mines, Preliminary Map P. 606, scale 1:50 000.

Hewitt, D.F.
1972: Paleozoic Geology of Southern Ontario; Ontario Division of Mines, Geological Report 105, 18 p. Accompanied by Map 2254, scale 1:1 013 760.

Hewitt, D.F. and Cowan, W.R.
1969: Sand and Gravel in Southern Ontario; Ontario Department of Mines, Open File Report 5029, Supplement to Industrial Mineral Report 29, 149 p. Accompanied by Map 2184, scale 1:1 013 760.

Karrow, P.F.; Davies, L.L.; and McClymont, W.R.
1972: Woodstock Sheet, Southern Ontario; Ontario Department of Mines, Preliminary Map P. 169, Bedrock Topography Series, scale 1:50 000.

Ontario
1981: The Pits and Quarries Control Act, 1971; Revised Statutes of Ontario, 1980, Chapter 378, Queen's Printer for Ontario

Ontario Interministerial Committee on National Standards and Specifications (Metric Committee)
1975: Metric Practice Guide; 67 p.

Ontario Ministry of Intergovernmental Affairs
1981: Municipal Directory 1981; Queen's Printer for Ontario, 191 p.

Ontario Ministry of Natural Resources
1980: Statistics 1980; Ontario Ministry of Natural Resources, 122 p.

Ontario Ministry of Treasury, Economics and Intergovernmental Affairs

1974: Municipal Directory 1974; Queen's Printer for Ontario, 128 p.

Robertson, J.A.
1975: Mineral Deposit Studies, Mineral Potential Evaluation, and Regional Planning in Ontario; Ontario Division of Mines, Miscellaneous Paper 61, 42 p.

Sado, E.V.
1980a: The Quaternary Stratigraphy and History of the Lucan Map Area, Southwestern Ontario; Unpublished MSc. Thesis, University of Waterloo, 146 p.
1980b: Sand and Gravel in North Dorchester Township, Middlesex County, Ontario; Ontario Geological Survey, Open File Report 5312, 18 p.

Sado, E.V. and Jones, D.
1980: Drift Thickness of the Lucan Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P. 2359, Drift Thickness Series, scale 1:50 000.

Sado, E.V. and Vagners, U.J.
1975: Quaternary Geology of the Lucan Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P. 1048, Geological Series, scale 1:50 000.

Sanford, B.V.
1969: Geology of the Toronto-Windsor Area, Ontario; Geological Survey of Canada, Map 1263 A, scale 1:250 000.

Signpost, The
1980: Potential Wealth Under Our Feet; The Signpost, No. 127, Vol. 2, March 20, 1980, Dorchester, Ontario.

APPENDIX A - SUGGESTED ADDITIONAL READING

American Geological Institute
1972: Glossary of Geology; Washington, D.C., 858 p.

Bauer, A.M.
1970: A Guide to Site Development and Rehabilitation of Pits and Quarries; Ontario Department of Mines, Industrial Mineral Report 33, 62 p.

Cowan, W.R.
1977: Toward the Inventory of Ontario's Mineral Aggregates; Ontario Geological Survey, Miscellaneous Paper 73, 19 p.

Fairbridge, R.W. (ed.)
1968: The Encyclopedia of Geomorphology; Encyclopedia of Earth Sciences, Vol. III, Reinhold Book Corp., N.Y., 1295 p.

Flint, R.F.
1971: Glacial and Quaternary Geology, John Wiley and Sons Inc., 892 p.

Hewitt, D.F.
1960: The Limestone Industries of Ontario; Ontario Department of Mines, Industrial Mineral Circular 5, 177 p.
1964a: Building Stones of Ontario, Part I Introduction; Ontario Department of Mines, Industrial Mineral Report 14, 43 p.
1964b: Building Stones of Ontario, Part II Limestone; Ontario Department of Mines, Industrial Report 15, 43 p.
1964c: Building Stones of Ontario, Part III Marble; Ontario Department of Mines, Industrial Mineral Report 16, 89 p.
1964d: Building Stones of Ontario, Part IV Sandstone; Ontario Department of Mines, Industrial Mineral Report 17, 57 p.
1972: Paleozoic Geology of Southern Ontario; Ontario Division of Mines, Geological Report 105, 18 p.

Hewitt, D.F. and Karrow, P.F.
1963: Sand and Gravel in Southern Ontario; Ontario Department of Mines, Industrial Mineral Report 11, 151 p.

Hewitt, D.F. and Vos, M.A.
1970: Urbanization and Rehabilitation of Pits and Quarries; Ontario Department of Mines, Industrial Mineral Report 34, 21 p.

Lowe, S.B.
1980: Trees and Shrubs for the Improvement and Rehabilitation of Pits and Quarries in Ontario; Ontario Ministry of Natural Resources, 71 p.

McLellan, A.G.; Yundt, S.E. and Dorfman, M.L.
1979: Abandoned Pits and Quarries in Ontario; Ontario Geological Survey, Miscellaneous Paper 79, 36 p.

Ontario Mineral Aggregate Working Party
1977: A Policy for Mineral Aggregate Resource Management in Ontario; Ontario Ministry of Natural Resources, 232 p.

Ontario Ministry of Natural Resources
1975: Vegetation for the Rehabilitation of Pits and Quarries; Forest Management Branch, Division of Forests, 38 p.

Peat, Marwick & Partners and
M.M. Dillon Limited
1981: Mineral Aggregate Transportation Study; Industrial Minerals Background Paper 1, 133 p. Summary Report 26 p.

Proctor and Redfern Limited
1974: Mineral Aggregate Study, Central Ontario Planning Region; Prepared for the Ontario Ministry of Natural Resources, over 100 p.

Proctor and Redfern Limited and
Gartner Lee Associates Limited
1975: Mineral Aggregate Study of Part of The Eastern Ontario Region; Prepared for the Ontario Ministry of Natural Resources, about 200 p.
1977: Mineral Aggregate Study and Geological Inventory, Southwestern Region of Ontario; Prepared for the Ontario Ministry of Natural Resources, about 200 p.

APPENDIX B - GLOSSARY

ABRASION RESISTANCE

Tests such as the Los Angeles Abrasion Test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

ABSORPTION CAPACITY

Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

AGGREGATE

Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

ALKALI-AGGREGATE REACTION

A chemical reaction between the alkalies of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

BLENDING

Required in cases of extreme coarseness, fineness or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

CAMBRIAN

The first period of the Paleozoic Era, thought to have covered the time between 570 and 500 million years ago; the Cambrian precedes the Ordovician Period.

CLAST

An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of a larger rock mass. Synonyms include particle and fragment.

CRUSHABLE AGGREGATE

Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

DELETERIOUS LITHOLOGY

A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

DEVONIAN

A period of the geological past thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

DOLOSTONE

A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

DRIFT

A general term for all unconsolidated rock debris transported from one place and deposited

in another; distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

DRUMLIN

A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were deposited beneath an advancing ice sheet, and were shaped by its flow.

EOLIAN

Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

FINES

A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

GLACIAL LOBE

A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced and retreated numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

GRADATION

The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulder	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

GRANULAR BASE COURSE

Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

HOT-LAID (OR ASPHALTIC) AGGREGATE

Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3 and 4), or as binder course (H.L. 2, 6 and 8) used to bind the surface course to the underlying granular base course.

LITHOLOGY

The description of rocks on the basis of such characteristics as color, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

MELTWATER CHANNEL

A drainage way, often terraced, produced by water flowing away from a melting glacier margin.

ORDOVICIAN

An early period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

PALEOZOIC ERA

One of the major divisions of the geologic time scale thought to have covered the time between 570 and 230 million years ago, the Paleozoic Era (or Ancient Life Era) is subdivided into six geologic periods, of which only four (Cambrian, Ordovician, Silurian and Devonian) can be recognized in southern Ontario.

PETROGRAPHIC EXAMINATION

An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of the aggregate.

PLEISTOCENE

An Epoch of the recent geological past including the time from approximately 1.8 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

POSSIBLE RESOURCE

Reserve estimates based largely on broad knowledge of the geological character of the deposit and for which there are few, if any samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

SHALE

A fine-grained, sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

SILURIAN

An early period of the Paleozoic Era thought to have covered the time between 435 and 395 million years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

SOUNDNESS

The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

TILL

Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

WISCONSINAN

Pertaining to the last glacial period of the Pleistocene Epoch in North America. The Wisconsinan began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

APPENDIX C - GEOLOGY OF SAND AND GRAVEL DEPOSITS

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

ICE-CONTACT TERRACES (ICT)

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous due to extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive due to the variability of the deposits both in terms of quality and grain size distribution.

KAMES (K)

Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good-quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the rare presence of excess fines (silt- and clay-sized particles).

ESKERS (E)

Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout southern Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

UNDIFFERENTIATED ICE-CONTACT STRATIFIED DRIFT (IC)

This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits due to their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

OUTWASH (OW)

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

ALLUVIUM (AL)

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and it has generally low value due to the presence of excess silt- and clay-sized material. There are few large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

GLACIOLACUSTRINE BEACH DEPOSITS (LB)

These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the source material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

GLACIOLACUSTRINE DELTAS (LD)

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

GLACIOLACUSTRINE PLAINS (LP)

The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources due to their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

END MORAINES (EM)

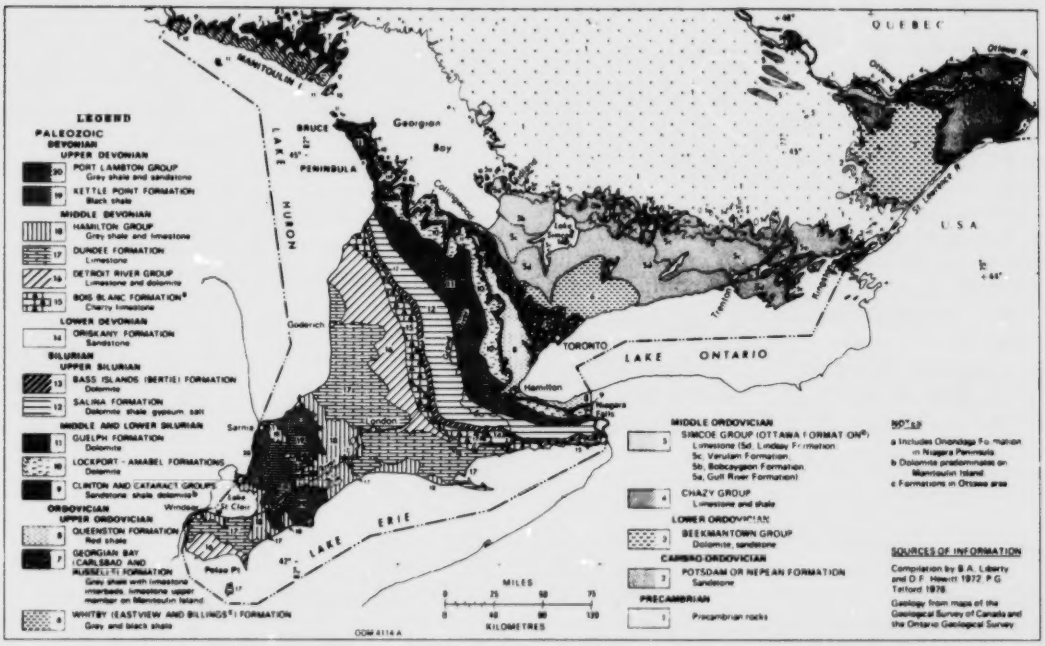
These are belts of glacial drift deposited at, and parallel to, glacier margins. End moraines commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best resource areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

WINDBLOWN DEPOSITS (WD)

Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments almost always consist of fine to coarse sand and are usually well sorted. The probability of locating crushable aggregate in windblown deposits is very low.

APPENDIX D - GEOLOGY OF BEDROCK DEPOSITS



BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

BASS ISLANDS FORMATION (UPPER SILURIAN)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium- to massive-bedded, aphanitic, brown dolostone with shaly partings. Thickness: 35 to 60 feet (11 to 18m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville, and Dunville. Los Angeles Abrasion Test: 17-35% loss; Absorption: 1.4%. Shaly parts are unsuitable for aggregate due to high soundness losses.

BOBCAYGEON FORMATION (MIDDLE ORDOVICIAN)

Composition: Compact, homogeneous, medium to thin-bedded, fine-grained limestone with some argillaceous and shaly partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

BOIS BLANC FORMATION (LOWER-MIDDLE DEVONIAN)

Composition: Brownish grey, medium-crystalline, medium- to thin-bedded, cherty limestone, commonly fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 61 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High chert content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

DUNDEE FORMATION (MIDDLE DEVONIAN)

Composition: Fine- to medium-crystalline, brownish grey, medium- to thick-bedded, dolomitic limestone with shaly partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone.

Used at St. Marys for portland cement. Los Angeles Abrasion Test: 22-32% loss; Absorption: 0-4%.

GULL RIVER FORMATION (MIDDLE ORDOVICIAN)

Composition: Member A: thin- to thick-bedded, interbedded, grey argillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield, Victoria County, and Uhthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption, and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

LOCKPORT AND AMABEL FORMATIONS (MIDDLE SILURIAN)

Composition: Amabel Formation (Waterdown to the Bruce Peninsula): massive, fine-crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent to the Amabel Formation from Waterdown to Niagara Falls): thin- to massive-bedded, fine- to medium-grained dolostone. Thickness: Amabel Formation: maximum observed thickness of 84 feet (26 m). Lockport Formation: up to 130 feet (40 m). Uses: The Lockport and Amabel Formations have been used to produce lime, crushed stone, concrete aggregate and building stone throughout their area of occurrence, and are a resource of provincial significance. Los Angeles Abrasion Test: 21-35% loss; Soundness Test: 2.0% loss; Absorption: 0.4-1.6%.

ONONDAGA FORMATION (MIDDLE DEVONIAN)

(Equivalent to the Detroit River Group, with a textural change) Composition: Edgecliff Member: medium-bedded, fine- to medium-grained, dark grey cherty limestone with an estimated thickness of 25 to 30 feet (8 to 9 m). Clarence Member: massive-bedded, dark grey brown, fine-grained, very cherty limestone having an estimated thickness of 26 feet (8 m). Moorehouse Member: medium-bedded, dark grey brown or purplish brown, fine- to coarse-grained, variably cherty limestone with an estimated thickness of 15 to 25 feet (5 to 8 m). Uses: Quarried for crushed stone on the Niagara Peninsula at Welland and Port Colborne. High chert content makes much of the material unsuitable for concrete aggregate.

OTTAWA FORMATION (MIDDLE ORDOVICIAN)

Composition: Lower Phase (Lowville and Pamela Beds): shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase (Hull, Rockland, and Leray Beds): pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall Beds): pure and impure crystalline limestone with few to numerous shaly partings, 450 to 475 feet (137 to 145 m) thick near Ottawa. Uses: The Leray, Rockland, and Hull Beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull Beds are an excellent source of lime for cement production and agricultural uses.

OXFORD FORMATION (LOWER ORDOVICIAN)

Composition: Medium- to thick-bedded, grey dolostone, with some shaly partings. Thickness: 240 feet (73 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville, and Smiths Falls.

BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES

DETROIT RIVER GROUP (MIDDLE DEVONIAN)

(Equivalent to the Onondaga Formation in the Niagara Peninsula, with a textural change) Composition: Near Beachville, the group consists of medium- to micro-crystalline, medium-bedded, high-purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (30 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high-purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces 80% of Ontario's cement. Its dolomitic reefal facies is also important for lime production to the north. It is generally unsuitable for crushed stone. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for

crushed stone.

GRENVILLE MARBLE (PRECAMBRIAN)

Composition: Recrystallized white limestone and dolostone, fine- to coarse-grained, usually of high chemical purity. Uses: Lime production, but also in small amounts for terrazzo chips, poultry grit, decorative stone, and building stone.

GUELPH FORMATION (MIDDLE SILURIAN)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. The Guelph Formation and the underlying Amabel Formation have a combined thickness of 200 feet (61 m) on the Niagara Peninsula and more than 400 feet (122 m) on the Bruce Peninsula. Uses: The main use is for dolomitic lime in the construction industry. The formation is quarried near Hamilton and Guelph.

LINDSAY FORMATION (MIDDLE ORDOVICIAN)

Composition: Lower Member: fine-crystalline, rubbly, nodular-weathering limestone. Upper Member: grey calcareous claystone with shaly partings and bioclastic layers. The rock is "soft" and weathers to rubble. Both members are characterized by low dolomite content and by numerous clayey partings. Uses: Quarried at Picton, Ogden Point and Bowmanville for cement. The formation is generally unsuitable for crushed stone, concrete aggregate, or granular base course.

VERULAM FORMATION (MIDDLE ORDOVICIAN)

Composition: Fossiliferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and commonly weathers to rubble. Thickness: 200 to 300 feet (61 to 91 m). Uses: Quarried at Picton, Ogden Point, and Mara Township for cement. The formation is unsuitable for crushed stone due to clay impurities, many clayey interbeds, and low abrasion resistance, high soundness losses and poor freeze and thaw resistance.

BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

GEORGIAN BAY FORMATION (UPPER ORDOVICIAN)

(Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas) Composition: Soft, fissile, blue grey shale with limey or sandy lenses in a few places. Thickness: 640 feet (195 m) at Toronto. Uses: Several producers in Metro Toronto and Cooksville produce brick and structural tile. Lightweight aggregate is also produced at Streetsville by heat expansion of the shale.

HAMILTON GROUP (MIDDLE DEVONIAN)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The group has six formations, but only the Arkona is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). Uses: The Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile and brick.

QUEENSTON FORMATION (UPPER ORDOVICIAN)

Composition: Red, thin- to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness: 400 to 500 feet (122 to 152 m). Uses: There are several large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region and one at Russell, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

NEPEAN (POTSDAM) FORMATION (CAMBRO-ORDOVICIAN)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

SALINA FORMATION (UPPER SILURIAN)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite, and gypsum.

The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia, and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor, and Sarnia.

WHITBY FORMATION (UPPER ORDOVICIAN)

(Formerly known as Collingwood Shale near Toronto) Composition: Brown to black fissile shale. Uses: Quarried at Bowmanville for use in cement production. Testing indicates that the Whitby Formation may produce satisfactory lightweight expanded aggregate.

DEPOSIT SYMBOL

Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel content is expressed as a percentage of crushable aggregate material. (Crushable aggregate material is defined as unprocessed gravel containing a minimum of 35% coarse aggregate larger than the # 4 sieve, and also a minimum of 20% larger than 1 inch sieve.) Thickness class is based on potential aggregate tonnage per acre. Type refers to geologic origin. Quality indicator describes objectionable grain size and lithology.

Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.

Thickness Class

Class	Average Thickness in feet (metres)	Tons per acre (Tonnes per hectare)
1	greater than 20 (> 6)	greater than 50,000 (> 112 000)
2	10-20 (3-6)	25,000-50,000 (56 000 - 112 000)
3	5-10 (1.5-3)	12,500 - 25,000 (28 000 - 56 000)
4	less than 5 (< 1.5)	less than 12, 500 (< 28 000)

Geological Type

AL	Older Alluvium	**K**	Kame
E	Esker	**LB**	Lacustrine Beach
EM	End Moraine	**LD**	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	**LP**	Lacustrine Plain
		OW	Outwash
ICT	Ice-Contact Terrace	**WD**	Windblown Forms

(see Appendix C for descriptions of Geological Types)

Quality Indicator

	If blank, no known limitations present.
C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.

TEXTURE SYMBOL

The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

SOURCES OF INFORMATION

Ontario

Ministry of Natural Resources

Hon. Alan W. Pope
Minister

W.T. Foster
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

NORTH DORCHESTER TOWNSHIP

MIDDLESEX COUNTY

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

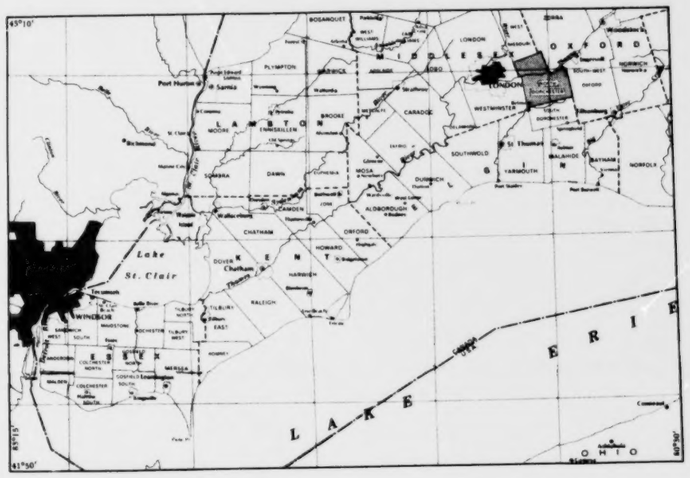
Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 40 I/14 40 P/2
40 I/15 40 P/3

© OMNR-OGS 1982



SYMBOLS

(Some symbols may not apply to this map.)

Geological and aggregate thickness boundary. Shading indicates deposit area.

Buried geological and aggregate thickness boundary. Shading indicates deposit area.

Quality Indicator

If blank, no known limitations present.

- **C** Clay and/or silt (fines) present in objectionable quantities.
- **L** Deleterious lithologies present.
- **O** Oversize particles or fragments present in objectionable quantities.

TEXTURE SYMBOL

The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Natural Resources.

Selected drilled water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

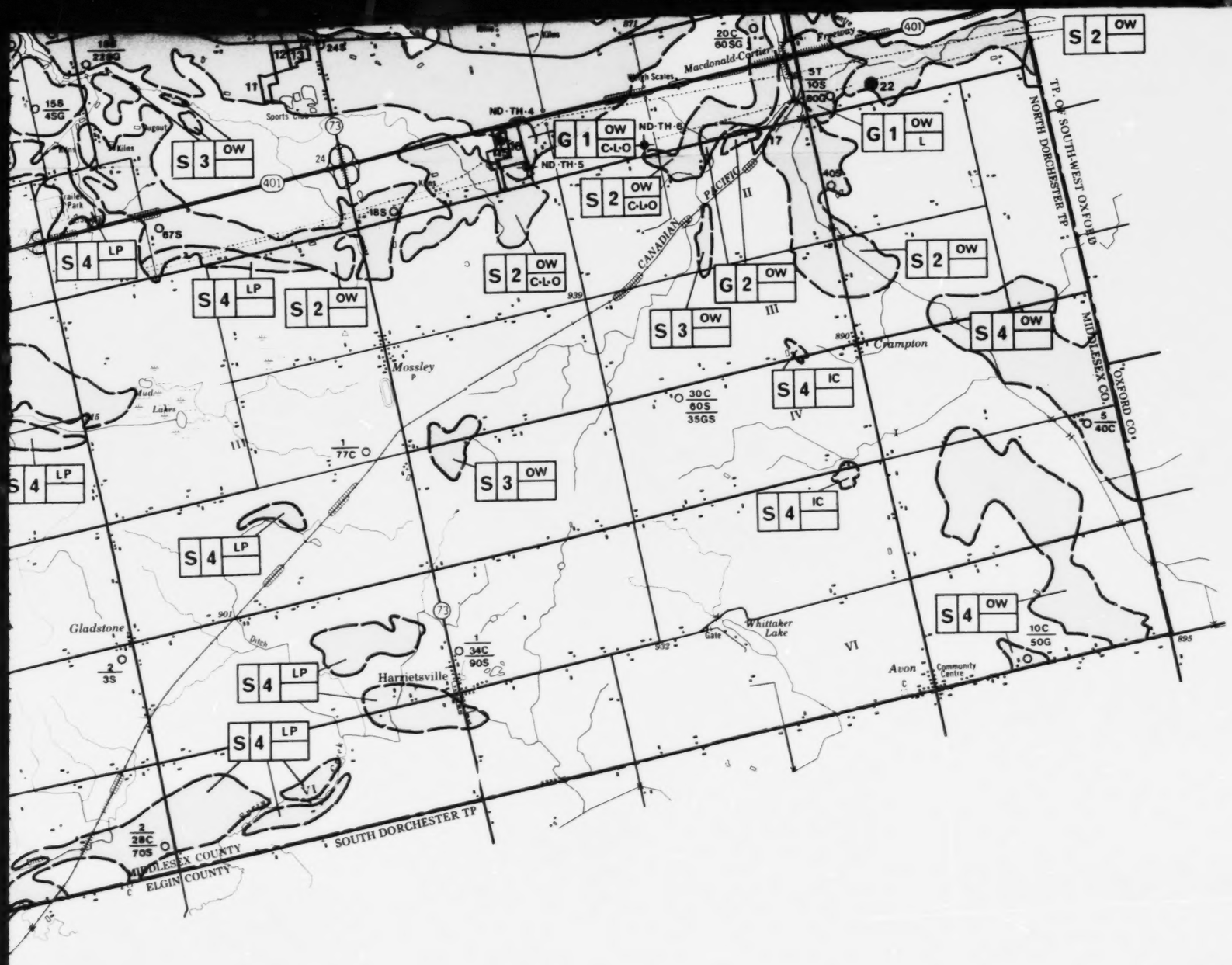
Geology by: P.J. Barnett et al., 1976.
W.R. Cowan, 1975.
A. Dreimanis, 1970.
E.V. Sado and U.J. Vagners, 1975.

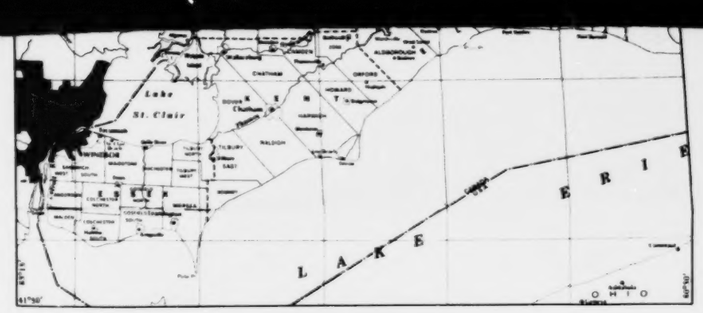
Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 74.

This map is published with the permission of E.G. Pye, Director, Ontario Geological Survey.
Issued 1982.

Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.





SYMBOLS

(Some symbols may not apply to this map.)

Geological and aggregate thickness boundary. Shading indicates deposit area.

Buried geological and aggregate thickness boundary. Shading indicates deposit area.

Municipal boundary.

2 — Licenced property boundary; Property number: see Table 2.

3 — Unlicenced sand or gravel pit*; Property number: see Table 2.
*Abandoned pit or wayside pit operating on demand under authority of a permit.

ND-TH-2 — Selected test hole location; Identification number: see Table 7.

6 / 23 G — Selected drilled water well location; reported thickness of material (in feet); reported type of material (number only - overburden, T - till, G - gravel, S - sand, C - clay, Bk - bedrock).

G 1 IC / C-O — Deposit Symbol: see below.

Texture symbol: see below.

(Continued at left margin)

NORTH DORCHESTER

WEST NISSOURI TP.
McWilliams
Trailer Park
Crumlin
Transformer Sta.
Cheese Factory
Youth Camp
Dugout
Gravel Pit
Poultry Farms
Saw Mill
Poultry Farm
Ditch
NORTH DORCHESTER TP.
CITY OF LONDON
CANADIAN NATIONAL
THAMES
RIVER
Dorchester
Fair Ground
Water 100
Town Hall
Cemetery
Auto Wreckers
Radio
Nilestown
Golf Course
Macdonald Cartier Freeway
401
74
73
TP. OF ZORRA
TP. OF SOUTH-WEST OXFORD
NORTH DORCHESTER TP.
OXFORD CO
MIDDLESEX CO
Middle Thames R.
Pits
Asphalt Plant
Putnam
Kilns
Animal Research Farm
Macdonald-Cartier
Auto Wrecker
Crampton
Mossley
CANADIAN PACIFIC
BM 865
871
889
939
973

Ministry of Natural Resources

Ontario

Hon. Alan W. Pope
Minister

W.T. Foster
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

NORTH DORCHESTER TOWNSHIP

MIDDLESEX COUNTY

MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

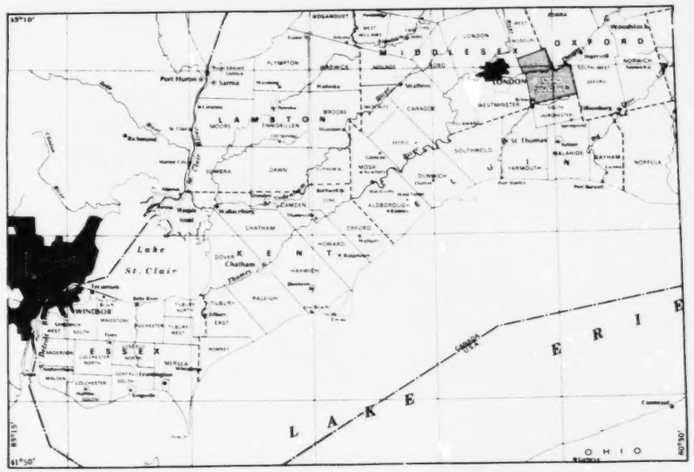
Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 40 I/14 40 P/2
40 I/15 40 P/3

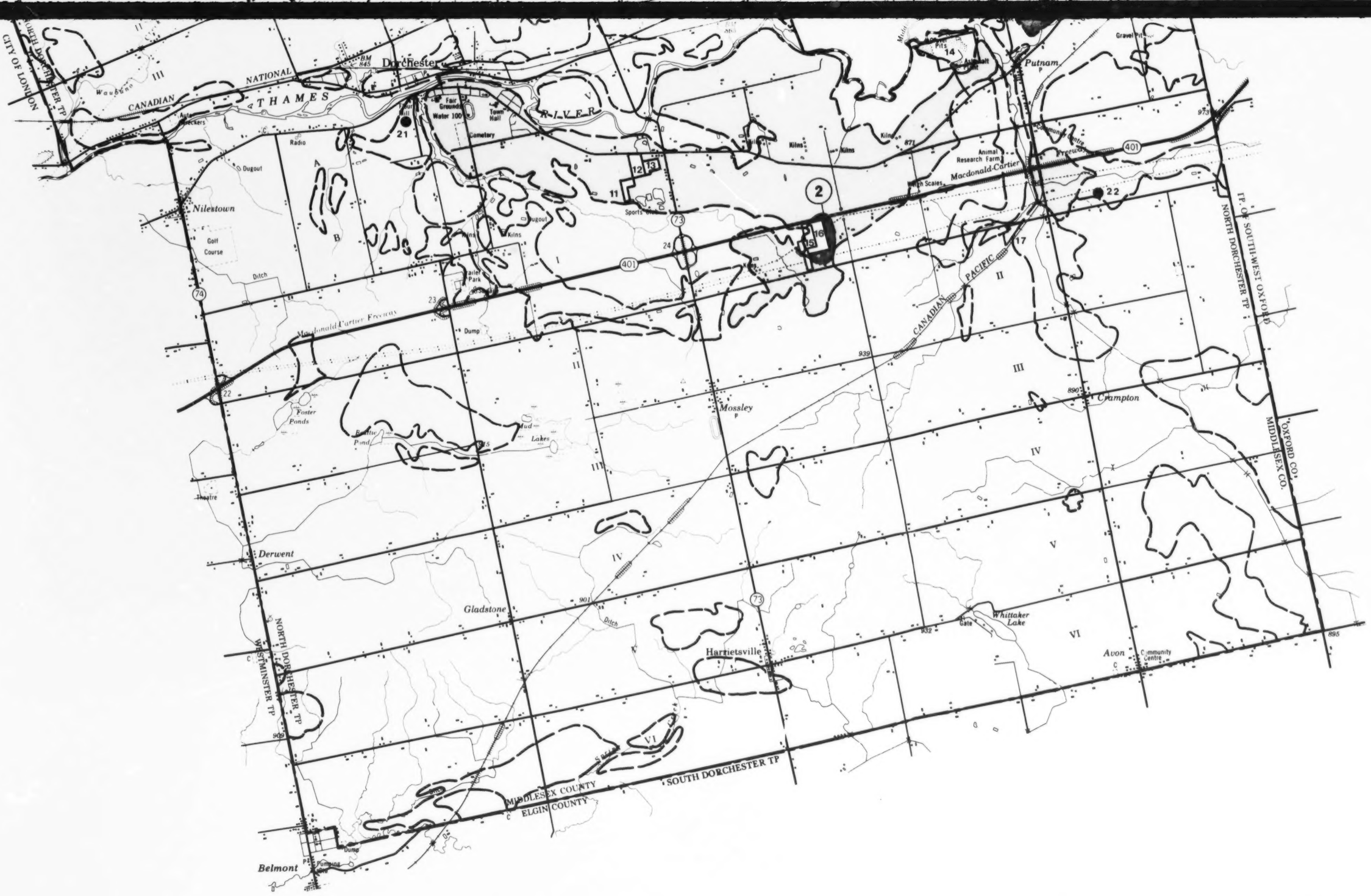
© OMNR-OGS 1982



SYMBOLS

(Some symbols may not apply to this map.)

- Geological and aggregate thickness boundary.
- Buried geological and aggregate thickness boundary.
- Municipal boundary.
- Selected sand and gravel resource area; Primary significance; Deposit number: see Table 3.
- Selected sand and gravel resource area; Secondary



NORTH DORCHESTER

NORTH DORCHESTER

SYMBOLS

(Some symbols may not apply to this map.)

- Geological and aggregate thickness boundary.
- Buried geological and aggregate thickness boundary.
- Municipal boundary.
- (2) Selected sand and gravel resource area; Primary significance; Deposit number: see Table 3.
- Selected sand and gravel resource area; Secondary significance.
- Selected sand and gravel resource area; Tertiary significance.
- 2 Licenced property boundary; Property number: see Table 2.
- ● 3 Unlicenced sand or gravel pit*; Property number: see Table 2.
  *Abandoned pit or wayside pit operating on demand under authority of a permit.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Geology by: P.J. Barnett et al., 1976.
W.R. Cowan, 1975.
A. Dreimanis, 1970.
E.V. Sado and U.J. Vagners, 1975.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 74.

This map is published with the permission of E.G. Pye, Director, Ontario Geological Survey.
Issued 1982.

WEST NISSOURI TP
McWilliams
Greenhouse
Saw Mill
Poultry Farm
Gravel Pit
Silo
Ditch
Trailer Park
Crumlin
Transformer Sta
Cheese Factory
DUNDEE FORMATION
Youth Camp
Dugout
NORTH DORCHESTER TP
TP OF ZORRA
CITY OF LONDON
Dorchester
NATIONAL
CANADIAN
THAMES
RIVER
Nilestown
Golf Course
Trailer Park
Service
Macdonald-Cartier Freeway
Dump
DETROIT RIVER GROUP
LUCAS FORMATION
Sports Club
Kilns
Gravel
Weigh Scales
Animal Research Farm
Community Centre
Campsite
Auto Wrecker
Putnam
Middle Thames R.
Gravel Pits
OXFORD CO
MIDDLESEX CO
N DORCHESTER TP
PACIFIC
CANADIAN
Crampton
Mossley
Foster Ponds
Beattie Pond
Mud Lakes
TP OF SOUTH-WEST OXFORD
MIDDLESEX CO
50
401
73
I
II
III
IV
A
B

Ministry of Natural Resources
Ontario

Hon. Alan W. Pope
Minister

W.T. Foster
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

NORTH DORCHESTER TOWNSHIP
MIDDLESEX COUNTY

MAP 3
BEDROCK RESOURCES

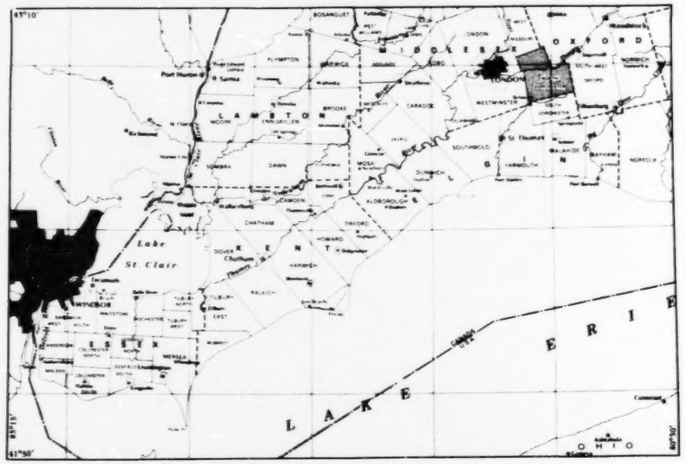
Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: **40 I/14** **40 P/2**
40 I/15 **40 P/3**

© OMNR-OGS 1982



LEGEND

PALEOZOIC

DEVONIAN

MIDDLE DEVONIAN

DUNDEE FORMATION

SYMBOLS

(Some symbols may not apply to this map.)

- Geological formation boundary.
- Geological formation member boundary.
- Formation thickness boundary (see text).
- 25 — Drift thickness contour: 25 foot (8 m) interval.
- Municipal boundary.
- 2 — Selected bedrock resource area; Deposit number:

DETROIT RIVER GROUP
LUCAS FORMATION

DUNDEE FORMATION

DUNDEE FORMATION

Nilestown

Derwent

Gladstone

Harrietsville

Crampton

Avon

Belmont

Whittaker Lake

Massley

Animal Research Farm

Macdonald-Cartier Freeway

401

73

CANADIAN PACIFIC

NATIONAL

CANADIAN

THAMES RIVER

TP. OF SOUTHWEST OXFORD

NORTH DORCHESTER TP

WESTMINSTER TP

SOUTH DORCHESTER TP

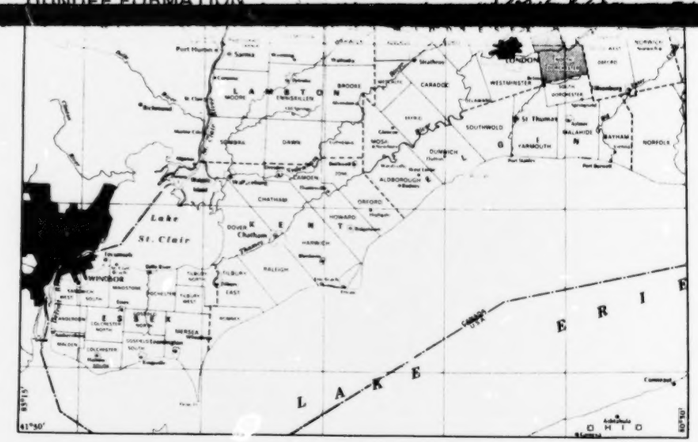
OXFORD CO.

MIDDLESEX CO.

MIDDLESEX COUNTY

ELGIN COUNTY

NORTH DORCHESTER



LEGEND

PALEOZOIC

DEVONIAN

MIDDLE DEVONIAN

DUNDEE FORMATION
Limestone

DETROIT RIVER GROUP

LUCAS FORMATION
Limestone

SYMBOLS

(Some symbols may not apply to this map.)

- Geological formation boundary.
- Geological formation member boundary.
- Formation thickness boundary (see text).
- 25 — Drift thickness contour: 25 foot (8 m) interval.
- Municipal boundary.
- (2) Selected bedrock resource area; Deposit number: see Table 6.
- Bedrock exposed or near surface; covered by less than 3 feet (1 m) of overburden: see Table 4.
- Bedrock covered by 3 to 25 feet (1 to 8 m) of overburden: see Table 4.
- Bedrock covered by 25 to 50 feet (8 to 15 m) of overburden: see Table 4.
- x Isolated bedrock outcrop.
- Q2 Licenced quarry boundary; Property number: see Table 5.
- Q3 Unlicenced quarry*; Property number: see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.
- O 28 Selected drilled waterwell location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Selected drilled water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: P.J. Barnett and A.L. Starkoski, 1978a, b.
A. Dreimanis, 1968.
P.F. Karrow et al., 1972.
E.V. Sado and D. Jones, 1980.
B.V. Sanford, 1969.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 74.

This map is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

Issued 1982.